PATENT SPECIFICATION

(11) 1214809

1214809

DRAWINGS ATTACHED

(21) Application No. 5929/67 (22) Filed 8 Feb. 1967
(23) Complete Specification filed 6 Feb. 1968
(45) Complete Specification published 2 Dec. 1970
(51) International Classification F 04 b 45/04
(52) Index at acceptance
F1N 1C2 2B
F2T 37D1 37F2

(72) Inventor PETER GEORGE WARE

(54) IMPROVEMENTS IN OR RELATING TO DIAPHRAGM PUMPS

(71) We, THE DUNLOP COMPANY LIMITED, a British Company of Dunlop House, Ryder Street, St. James's, London S.W.1, (formerly of 1 Albany Street, London N.W.1) do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to diaphragm-type pumps, that is, to pumps of the kind in which a flexible diaphragm formed from rubber or plastics material is employed as a deformable member constituting one wall of a compression chamber, the diaphragm being deformable to compress fluid in the chamber.

One disadvantage of employing a rubber diaphragm in a pump which is used as an air compressor is that the adiabatic rise in temperature which occurs when air is compressed may damage the diaphragm, and in practice diaphragm-type compressors have to be restricted to relatively low output rates in order to avoid the generation of excessive heat.

One object of the present invention is to provide a diaphragm-type pump which is capable of working at a relatively high output rate.

According to the invention, a diaphragm-type pump comprises a flexible diaphragm forming one wall of a compression chamber and comprising two spaced skins arranged to contain cooling fluid in the space therebetween, the space between the skins communicating with a cooling chamber.

A preferred form of the diaphragm-type pump according to the invention is an air compressor in which the space between the skins can be filled with water, the arrangement being such that the water is forced out from the diaphragm by compressive forces acting thereon during the compression stroke of the compressor and returns into the diaphragm during the induction stroke of the compressor.

One embodiment of the invention will now be described, by way of example with reference to the accompanying drawings in which:—

Figure 1 shows a cross-section through a pump comprising a flexible diaphragm according to the invention, taken on the axis of the pump cylinder, showing the diaphragm at the limit of its travel at the end of a compression stroke of the pump;

Figure 2 shows a cross-section through the pump shown in Figure 1 and taken on the same line but showing the diaphragm in a position between the limits of its stroke;

Figure 3 shows a plan view of a rubber spacing ring and its associated leaf springs which is shown in section in Figures 1 and 2; and

Figure 4 shows an enlarged view of a cross-section through the spacing ring of Figure 3 taken on the line IV—IV.

An air compressor 1 comprises a cylindrical housing 2 in which a compression chamber 3 is formed, one end of the compression chamber having conventional inlet and outlet valves 4 and 5 respectively, and the other end being formed by a flexible diaphragm 6 clamped between a pair of diaphragm support plates 7 which are secured to one end of a connecting rod 8. The other end of the connecting rod is carried on a crankshaft 9 which is rotated to produce reciprocating motion of the connecting rod in the axial direction of the housing 2.

The diaphragm 6 comprises a first thin rubber skin 10, adjacent the compression chamber 3, which is secured to a second thicker skin 11 spaced from the first skin by means of an annular rib 12 coaxial with the compression chamber and having a radius equal to half that of the compression chamber. A space is formed between the two skins and communicates through openings 13 in the annular rib with the outer peripheral region of the diaphragm. The rib 12 defines a periphery of a central region of the space between the skins and the openings 13 allow cooling fluid to flow into and out of the said central region.

The outer peripheral edge region of the diaphragm 6 comprises a rubber spacing ring 14 interposed between the first and second skins

[*Price 5s. 0d. (25p)*]

1. Die Aufgabe des Zwischenraumes hier, ist es eine Kühlflüssigkeit aufzunehmen.

2. Es gibt keine Verbindung des Zwischenraumes zum

10 and 11 respectively, and clamped between two clamping members in the form of a pair of castings 15, 16 which constitute respectively the cylinder and part of the cylinder head of the compressor. The mating faces of the castings are recessed to provide an annular cooling chamber 17 surrounding the compression chamber 3 and the radially outer surfaces of the castings are ribbed in the region 18 on an external surface of the cooling chamber to promote heat dissipation therefrom.

The surfaces of the cylinder 15, the cylinder head 16, and the diaphragm support plates 7 engageable with or engaging the diaphragm 6 are provided, in the region of the outer peripheral edge of the diaphragm, with rubber elements 26 bonded to the surfaces to reduce stress concentration in the diaphragm where it is clamped and provide a more gradual change in strain between the fixed and moving parts of the diaphragm at the limits of its stroke.

The rubber spacing ring 14 which separates the first and second skins 10 and 11 respectively of the diaphragm 6 at its outer edge is provided with a pair of diametrically opposite apertures in the form of slots 19, 20 which permit communication between the annular cooling chamber 17 and the space between the two skins of the diaphragm.

The slots 19, 20 are each provided with a non-return flap valve in the form of a thin arcuate metal leaf spring 21, 22 respectively, extending across the slot. The springs 21, 22 are bent to a suitable shape so that they can each be located in a circumferentially-extending recess 23 formed in the body of the spacing ring and extending across the associated slot. The springs are anchored in one end of the recess 23 at their ends 24 and their free ends 25 extend across their respective slots 19, 20 and are freely located in the other end of the recess 23 for movement in a generally radial direction with respect to the spacing ring 14 to seal off and re-open the slots. In order that one spring 21 will act as a coolant inlet valve and the other 22 as a coolant exhaust valve the springs 21, 22 are bent so that their free ends tend to lie, respectively, one against the radially outer side and the other against the radially inner side of its corresponding recess. The space within the diaphragm 6 and most of the space within the cooling chamber 17 is filled with water which is arranged to circulate through the diaphragm in the following manner:—

In operation, rotation of the crankshaft 9 causes an axial deflection and tilting of the central portion of the diaphragm 6 (see Figure 2), which is rigidly secured to the connecting rod 8 by its support plates 7, the volume of the compression chamber 3 being successively increased and decreased to provide the normal induction and pressure strokes of the compressor 1. On the compression stroke, as the pressure rises in the compression chamber the central portion of the diaphragm is squeezed and water is forced through the slot 20 associated with the spring 22 which acts as an exhaust valve, into the annular cooling chamber 17. On the induction stroke the reduced pressure in the compression chamber allows the diaphragm to return to its normal state, thus increasing the volume available within the diaphragm and drawing water back from the annular chamber, through the slot 19 which constitutes an inlet valve into the space within the diaphragm.

Each stroke of the pump thus causes a movement of water into or out of the diaphragm, providing a continuous exchange of cooling fluid which enables the first skin of the diaphragm to be cooled and the heat in the cooling water to be dissipated through the annular chamber and cooling fins. The amount of movement of the coolant in the arrangement described above is proportional to the rise in pressure and temperature within the compression chamber in each stroke, higher pressures causing a greater displacement of water from the diaphragm.

One advantage of the construction described above is that the pump is able to work at a higher rate than normal diaphragm-type pumps.

In alternative arrangements the annular spacing member may be provided with tangentially directed inlet and outlet slots which would have the effect of causing a continuous rotation of the body of the water contained in the annular cooling chamber and in the diaphragm itself, thus improving the efficiency of the cooling system.

WHAT WE CLAIM IS:—

1. A diaphragm-type pump comprising a flexible diaphragm forming one wall of a compression chamber and comprising two spaced skins arranged to contain cooling fluid in the space therebetween, the space between the skins communicating with a cooling chamber.

2. A diaphragm-type pump according to claim 1 wherein the cooling chamber is provided with apertures in communication with the space between the skins through the periphery of the skins, the arrangement being such that cooling fluid flows between the cooling chamber and the space between the skins in operation of the pump.

3. A diaphragm-type pump according to claim 1 or claim 2 wherein the skins are spaced from one another by means of an annular rib defining a periphery of a central region of the space between the skins, the rib having openings formed therein so that the cooling fluid flows into and out of the said central region in operation of the pump.

4. A diaphragm-type pump according to any of the preceding claims wherein one of the

two spaced skins is thinner than the other skin and is secured thereto.

5. A diaphragm-type pump according to any of the preceding claims wherein the skins are of rubber.

6. A diaphragm-type pump according to any of the preceding claims wherein external ribs are provided on the cooling chamber to promote heat dissipation therefrom.

7. A diaphragm-type pump according to any of the preceding claims wherein a resilient spacing ring is interposed between the two skins of the diaphragm at the outer peripheral edge thereof and the spacing ring with the two skins one on each side is clamped to the compression chamber, the spacing ring having apertures formed therein to permit passage of the cooling fluid therethrough.

8. A diaphragm-type pump according to any of the preceding claims wherein the inner skin of the diaphragm with respect to the compression chamber is thinner than the outer skin of the diaphragm.

9. A diaphragm-type pump according to claim 7 or claim 8 wherein the apertures formed in the spacing ring communicate with the cooling chamber.

10. A diaphragm-type pump according to any of claims 7 to 9 wherein the cooling chamber is in the form of an annulus surrounding the compression chamber.

11. A diaphragm-type pump according to claim 10 wherein the apertures formed in the spacing ring extend in generally tangential directions to promote circulation of the fluid in the cooling chamber.

12. A diaphragm-type pump according to any of claims 7 to 11 wherein the apertures formed in the spacing ring have associated therewith non-return valves, at least one valve being arranged to act as a coolant inlet valve and at least one other valve as a coolant exhaust valve.

13. A diaphragm-type pump according to claim 12 wherein at least one of the non-return valves is a flap valve comprising a thin leaf spring extending across the respective aperture formed in the spacing ring, one end of the spring being anchored on one side of the aperture and the other end of the spring being free to move in a generally radial direction with respect to the spacing ring to seal off and re-open the aperture formed therein.

14. A diaphragm-type pump according to any of the preceding claims wherein the diaphragm is clamped at its outer peripheral edge to the compression chamber between two clamping members, at least one of the clamping members having a rubber element engageable with the diaphragm to reduce stress concentration therein.

15. A diaphragm-type pump according to any of the preceding claims wherein means for deforming the diaphragm to operate the pump comprises a diaphragm support plate having a rubber element engaging the diaphragm to reduce stress concentration therein.

16. A diaphragm-type pump according to any of the preceding claims arranged as an air compressor in which the space between the skins can be filled with water, the arrangement being such that the water is forced out from the diaphragm by compressive forces acting thereon during the compression stroke of the compressor and returns into the diaphragm during the induction stroke of the compressor.

17. A diaphragm-type pump constructed and arranged substantially as described herein and illustrated in the accompanying drawings.

R. I. G. McKAY,
Agent for the Applicants.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1970.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1214809 COMPLETE SPECIFICATION

1 SHEET *This drawing is ~~a~~ reproduction of the Original on a reduced scale*

FIG. 1

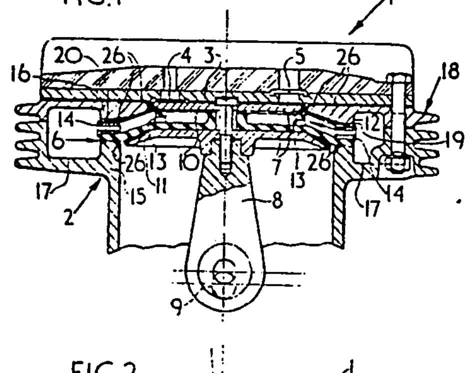

FIG. 2

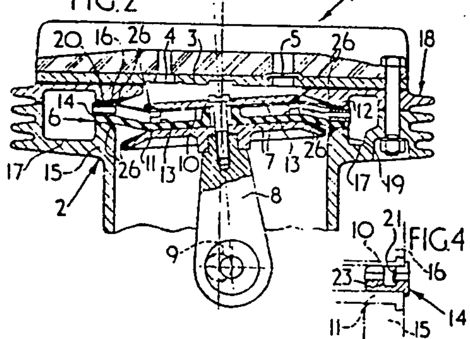

FIG. 4

FIG. 3